NOAA FISHERIES

NW Fisheries Science Center

Overview of West Coast Stock Assessment Process and Staff

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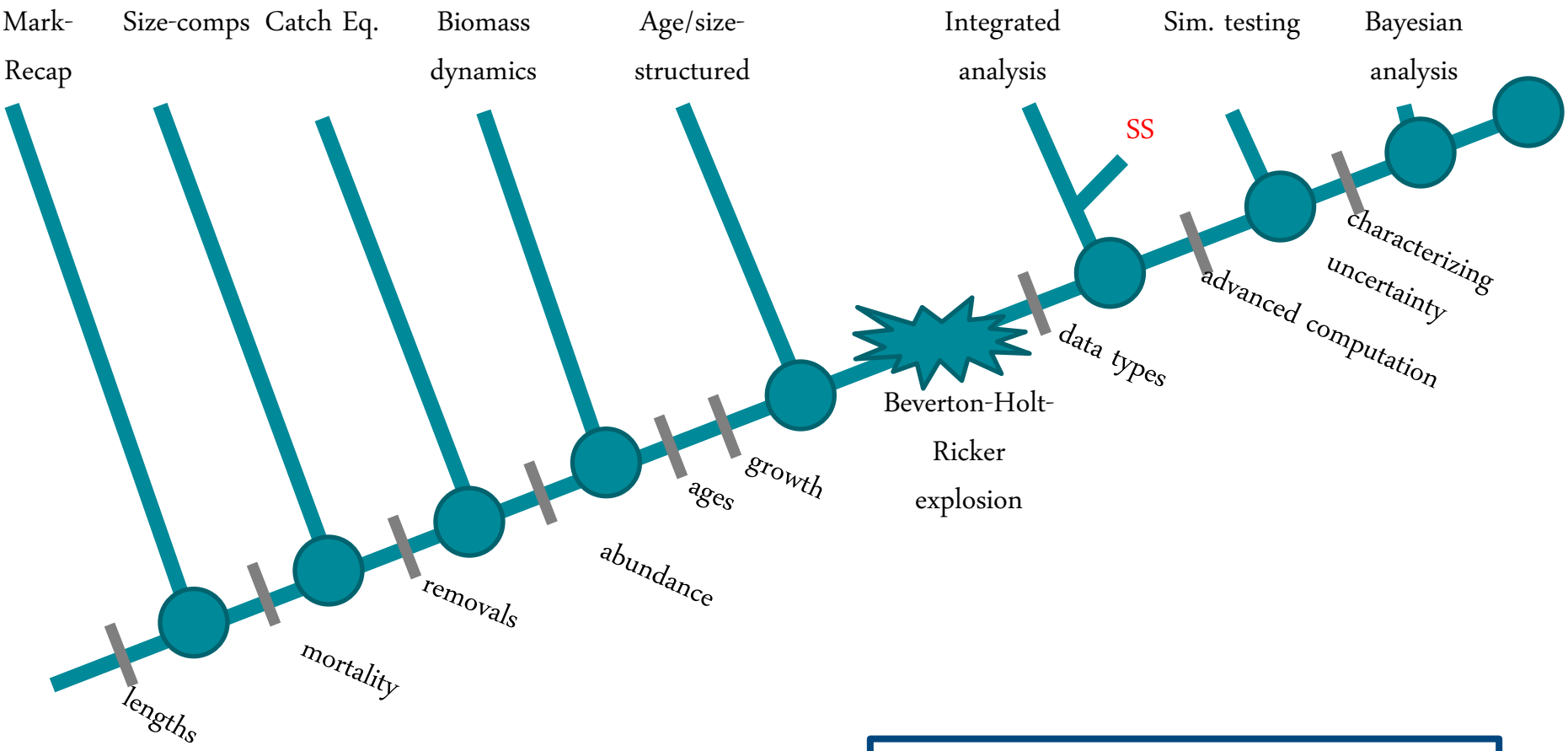
Responsible for 90+ stocks in the Groundfish FMP

- This leads to some issues for stock assessment
  - Too many stocks for which to conduct complex assessments
    - given staff and review resource limitations
  - Insufficient data to conduct complex assessments for many stocks
  - Average catch approaches for setting catch limits not ideal

History of Assessment Models used on U.S. West Coast

- Early variety of approaches
  - Stock Reduction Analysis (SRA)
  - Virtual Population Analysis (VPA) (cohort analysis)
  - Yield per Recruit Analysis (YPA)
- Later dominated by Statistical Catch at Age (CAA)
  - SS (SS1)
  - Independent models implemented in ADMB
  - SS2 – SS3 (in ADMB)

How did we get here?: Evolution of fisheries models

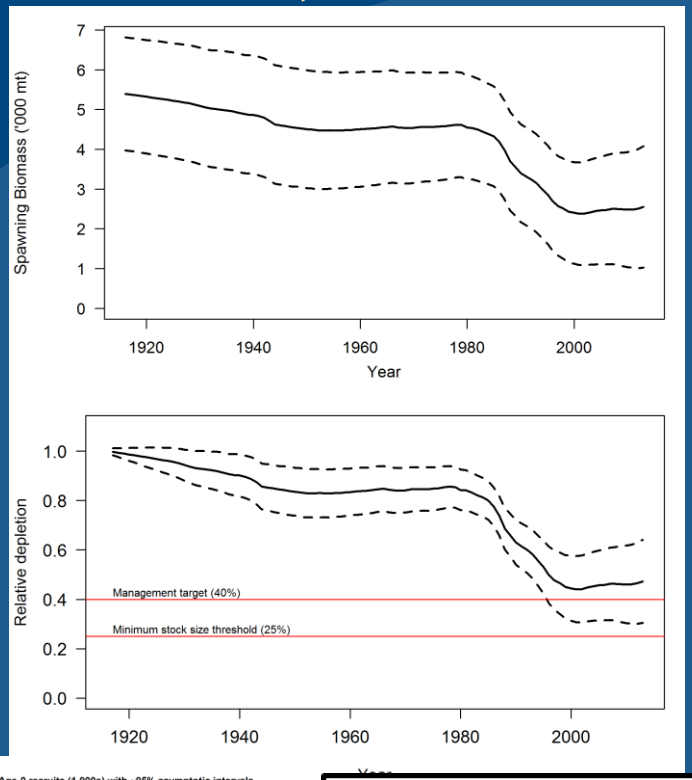


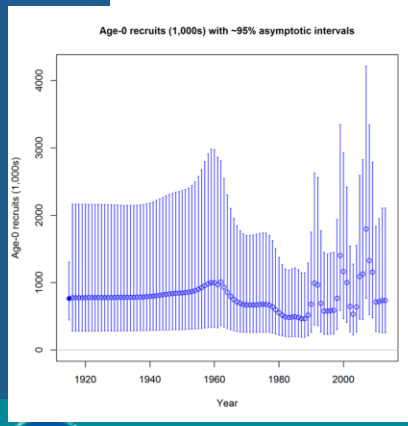
Evolving towards more sophisticated, complex, & data-rich/needy models

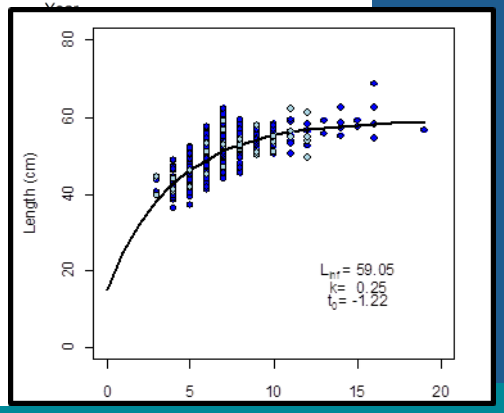
Advantages of Stock Synthesis

- Statistical catch-at-age models incorporate more realistic population dynamics
- Why Stock Synthesis?
  - Complex model which allows for a large variety of data types and model choices
  - New features can be added (as time allows)
  - Each version extensively tested and debugged
  - Shared R code for outputs (R4SS) and inputs
  - West coast assessment scientists have long history of working with SS and Rick Methot

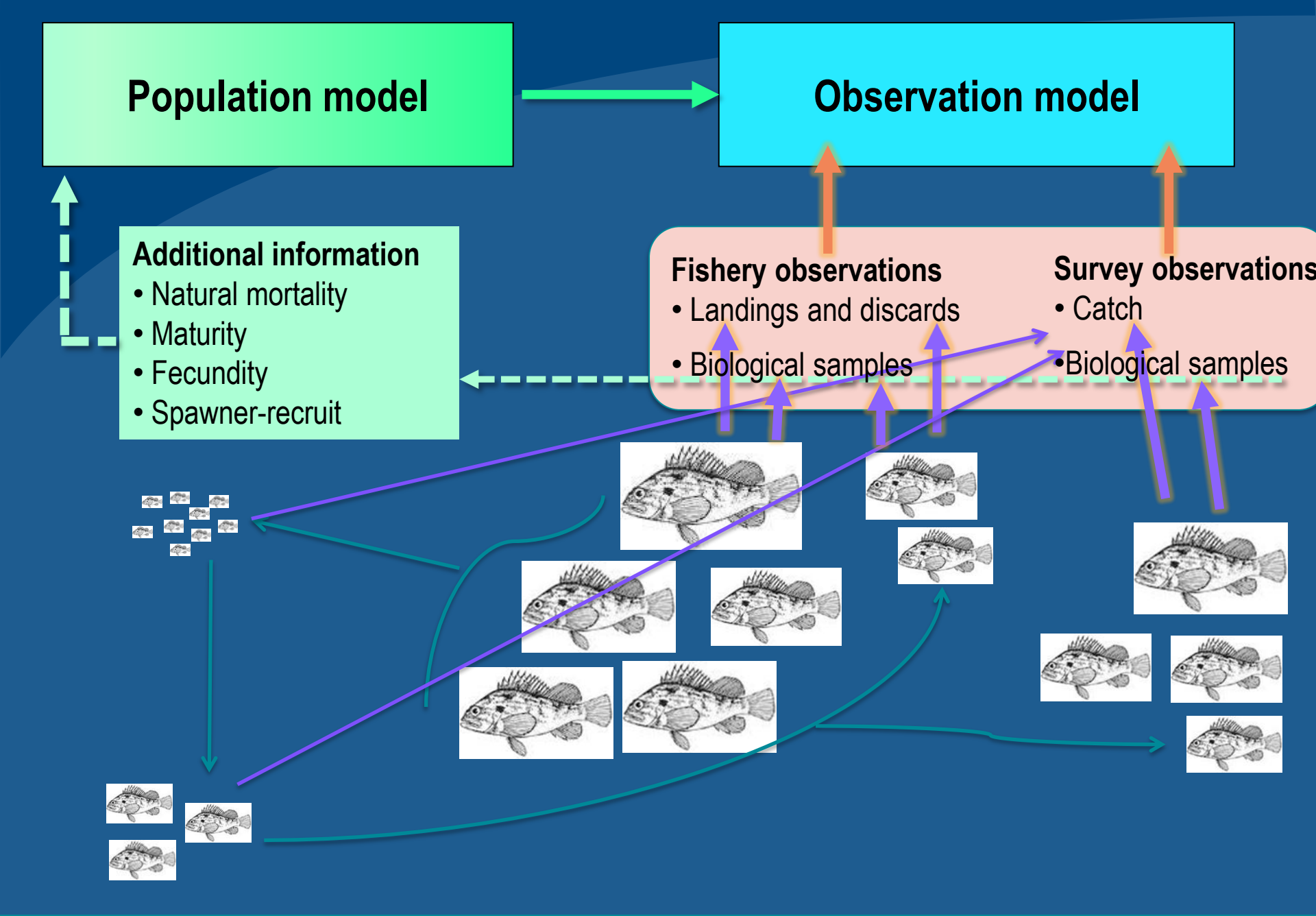
Scale, Status and Productivity



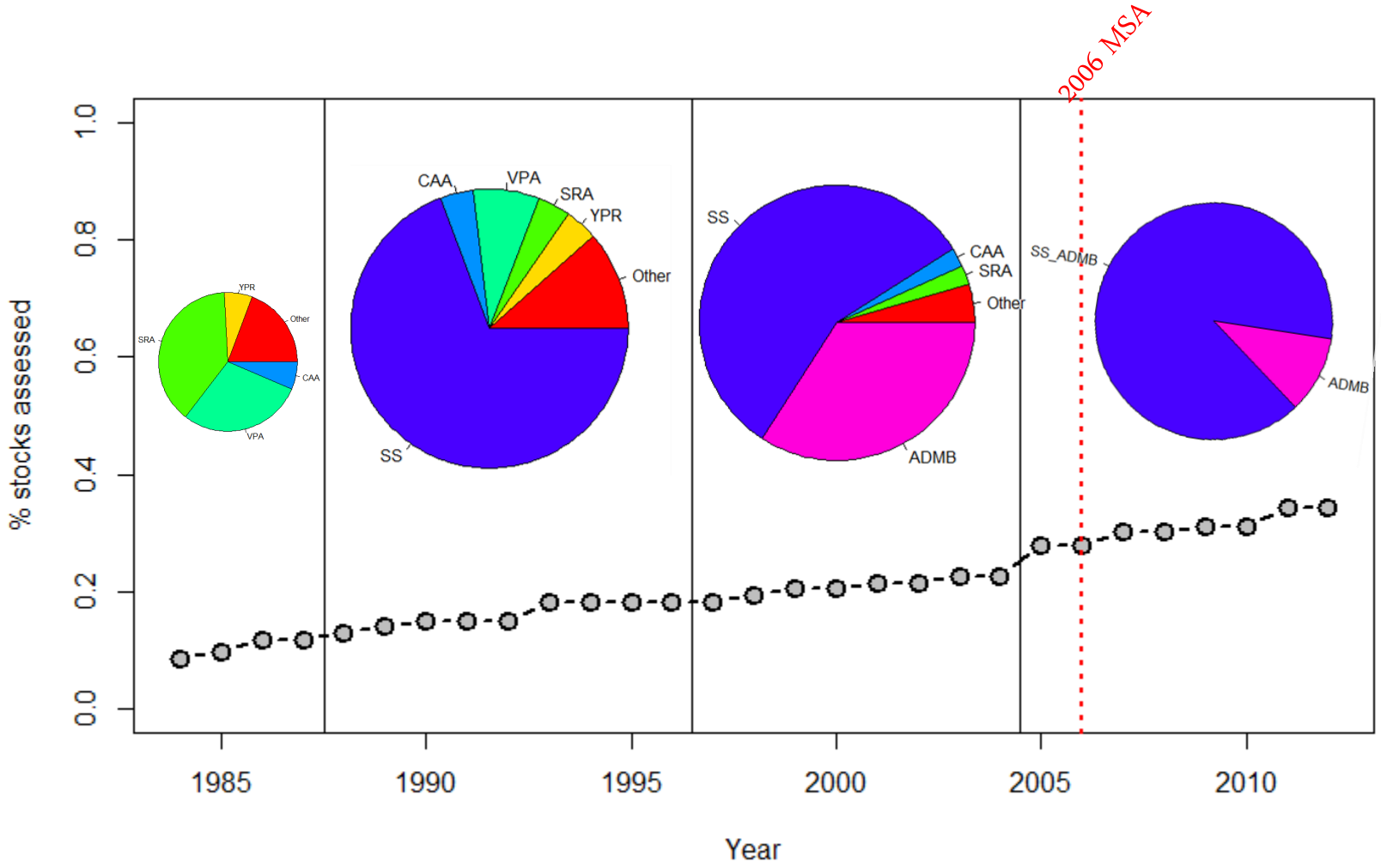




- Scale: Absolute level of biomass
- Status: Relative level of biomass
- Productivity: Natural rate of biomass change


Population model
Observation model
Additional information
• Natural mortality
• Maturity
• Fecundity
• Spawner-recruit
Fishery observations
• Landings and discards
• Biological samples
Survey observations
• Catch
•Biological samples

Progression of benchmark stock assessment models for the U.S. Pacific West Coast through 2011/2012



Assessment Levels/Categories

National Assessment Levels (SAIP 2011)

0. None
1. Index only
2. Simple life history equilibrium models
3. Aggregated production models
4. Size/age/stage-structured models
5. Space/Seasons/Ecosystem included

= "Adequate"

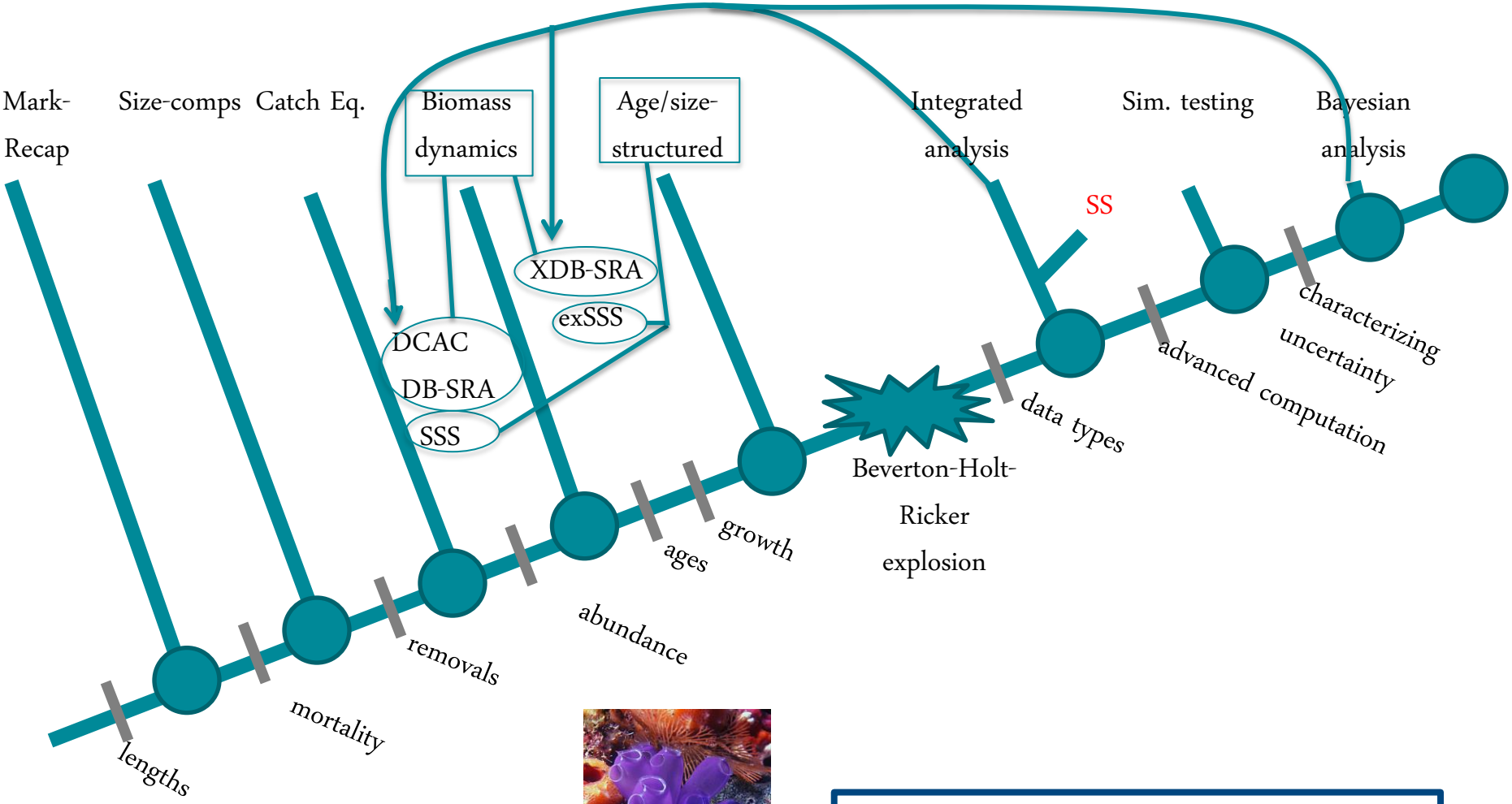
PFMC Assessment Categories

3. *Data-poor*
2. *Data-moderate* (includes some *benchmark* assessments)
1. *Data-rich* (includes most *benchmark* assessments)

Ability to Assess 90+ stocks in the Groundfish FMP:

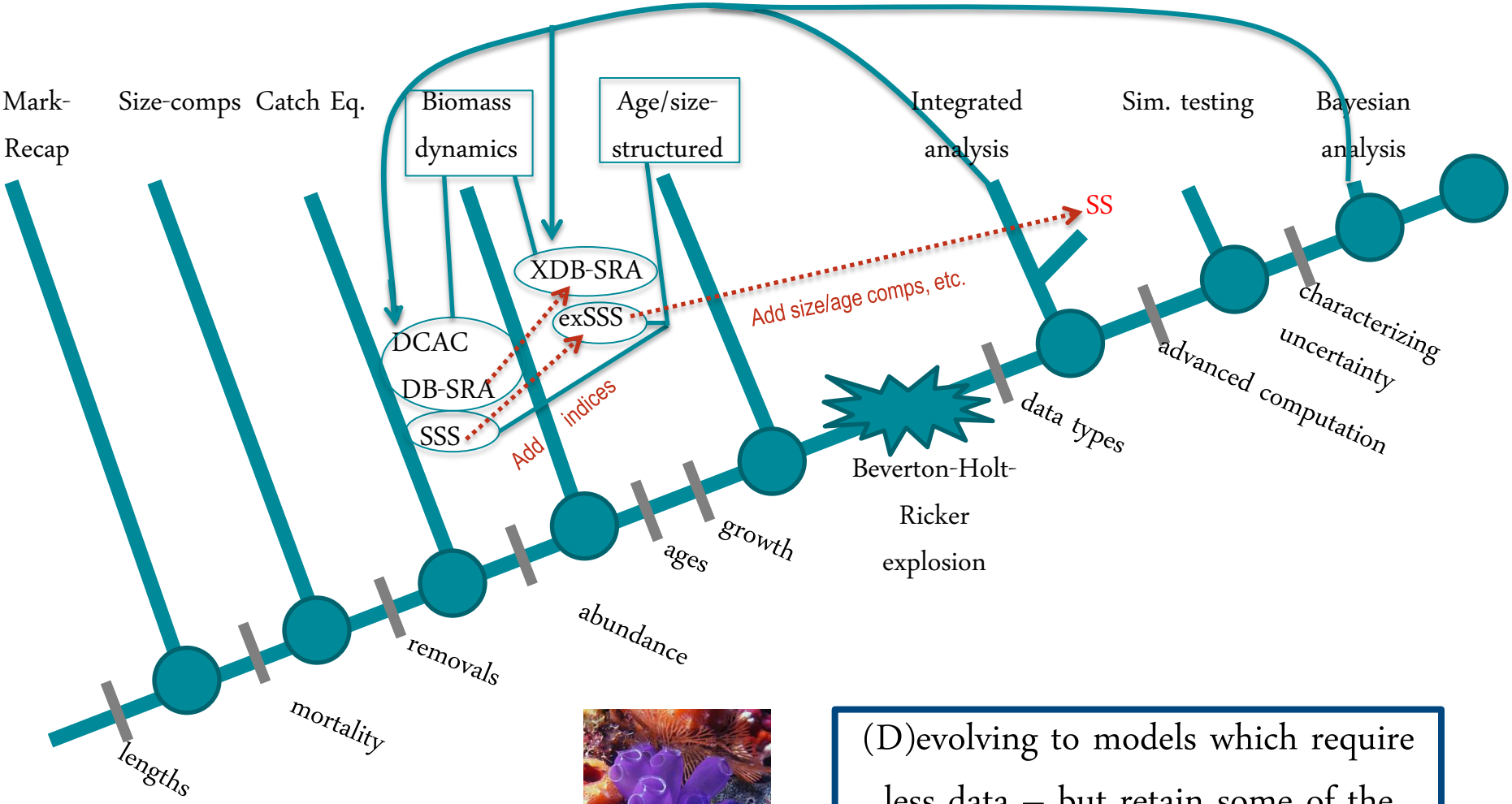
- Issues
  - Insufficient data to conduct complex assessments for many stocks
    - Trawl survey does not cover untrawlable habitat or nearshore areas
  - Insufficient resources to conduct complex assessments for others
  - Average catch approaches to setting catch limits not ideal
- Approach
  - Develop new methods
    - Data-poor – catch data + some life history
      - Simple, standard models; minimal review needed
    - Data-moderate – add in index of abundance
      - Intermediate complexity and level of review

How did we get here?: (d)evolution of fisheries models



(D)evolving to models which require less data – but retain some of the features of more complex models

How did we get here?: (d)evolution of fisheries models



(D)evolving to models which require less data – but retain some of the features of more complex models

- And can be easily expanded with more data

Four Levels of Assessments

1. Benchmark (Full)
2. Update of benchmark
3. Data-Moderate
4. Data-Poor

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4. Data-Poor

+ 3 more “assessment products”:

- Rebuilding Analyses
- Catch Reports
- Additional analyses requested by the PFMC

Benchmark Assessments

See C.2. for more information

- Typically use Stock Synthesis:
  - Allows for estimation of selectivity, natural mortality, productivity, recruitment, stock size; use of Bayesian priors, etc.
- Considerable exploration of uncertainty and model sensitivity
- Estimates of OFL (using MSY proxy) and status (% of SB0);
- Independent, interactive 4-5 day peer review of two assessments (STAR process), with final SSC review
- Used for 34 species since 2000

Update Assessments

- Updates of prior Benchmark assessments
- New/revised data in previously used series; no new series
- Model structure remains the same
  - Previously estimated parameters remain estimated
  - Previously fixed parameters remain fixed
- Reviewed by SSC
  - Following initial review by SSC Groundfish Sub-committee

Update Assessments

- Relatively simple to implement in terms of model and data choices;
  - i.e. essentially none
  - Previously fixed parameters remain fixed, previously estimated parameters remain estimated, etc.
  - No new data sources/types
- Problems can arise that cannot be dealt with within an update:
  - Poor fits to new or revised data
  - Odd parameter estimates
  - New and exciting data streams/types cannot be used
  - While new information on parameters/historical catch, etc. is allowed, no re-evaluation of other parameters.

Data-Moderate Assessments

See C.4. for more information

- Recently-developed, intermediate between benchmark and data-poor
- Rely on catch data, 1 or more abundance indices, and assumptions about/priors on important parameters
- Methods underwent independent peer review (2012)
- 2013 assessments used STAR process;
  - Eventually will be reviewed by SSC Groundfish subcommittee
- Provide estimates of OFL and stock status
- "Adequate" assessments, developed/reviewed with fewer resources
- Successful initial use for 8 species in 2013

Data-Poor Assessments

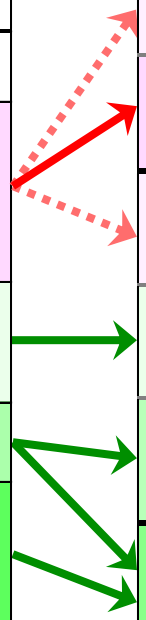
See C.3. for more information

- Simpler models with catch as only data input.
- Rely on prior distribution assumptions about important parameters:
  - current depletion ($B_{current}/B_{zero}$);
  - natural mortality rate (*M*);
  - F_{MSY}/M;
  - B_{MSY}/B_{zero}
- Produce uncertainty estimates, but model sensitivity not explored
- Methods underwent independent peer review (2011)
- Assessment results reviewed by SSC
- Provide information to set OFLs but not stock status;
- Generally a one-time analysis;
- Have been used for 50+ species since 2009.

Assessment Adequacy

Relating SAIP to Council Criteria

NMFS Stock Assessment Improvement Plan	
Level	**Features**
1	CPUE only
2	Simple equilibrium models with life history; Yield-per-recruit; Catch curve
3	Production models w/ catch and index
4	Age-/length-based models
5	Add ecosystem elements or spatial/temporal parameter variation



PFMC Assessment Categories		
Tier	**Features**	**Models used**
3-low	Catch-only; no life history	
3-med	Aggregate catch and M	**Data Poor:** DCAC
3-high	Annual catch with M and age at 50% maturity	**Data Poor:** DB-SRA / SSS
2-low	M * survey biomass estimate	Rogers, '96
2-med	Historical catch and trend info	**Data Moderate:** XDB-SRA / exSSS
2-high	Age-/length-structured, but high uncertainty	**Full** (STAR):SS
1	Reliable age/length data; estimate year-class strength	**Full** (STAR): SS

PFMC Assessment Categories

- SSC/Council assign assessments to Categories (1-3)
- Most **benchmark/update** assessments in **Category 1**
  - Those considered more uncertain may be placed in Category 2
- **Data-moderate** assessments in **Category 2**
- **Data-poor** assessments in **Category 3**
- Default scientific-uncertainty reductions from OFL to ABC
  - **Category 3 > Category 2 > Category 1**
- Assessment uncertainty may supersede default, if larger

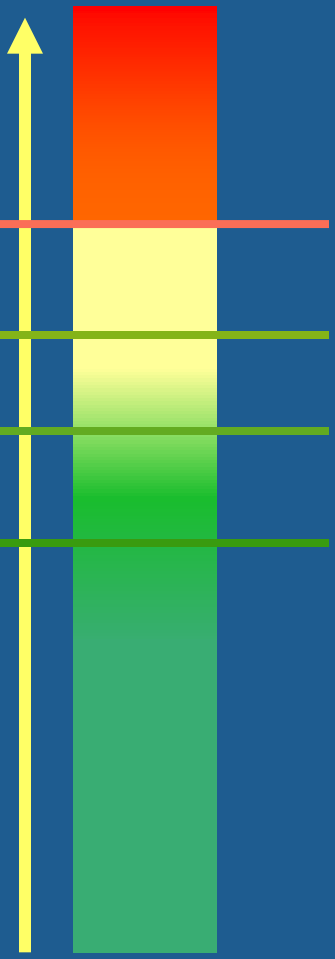
New Harvest Framework under MSA

OFL = Overfishing Level

ABC = Allowable Biological Catch

ACL = Annual catch limit

ACT = Annual catch target



Scientific uncertainty

Mgmt. uncertainty

$OFL \geq ABC \geq ACL \geq ACT$

$OFL = F_{MSY} * B_{EXploitable}$

$ABC = F_{MSY} * B_{EX} *$ Buffer

(size of default buffer partially based on assessment category)

Rebuilding Analyses

- Generally use stand-alone forward projection analysis program
  - SS configured to provide inputs
  - Prognosticates distribution of possible stock size under alternative harvesting schemes incorporating assessment model output on:
    - age composition at declaration and end year of assessment,
    - *M*,
    - fishery selectivity,
    - stock-recruit relationship
    - etc.
  - Provides catch projections, SPR, year of rebuild, uncertainty.
- XDB-SRA model has own rebuilding analysis approach

Catch Reports

- Reporting of catch over recent years with best available data to ensure that catch levels are at or below the ACL.
  - An alternative to updates for rebuilding species with long rebuilding times and marginal indices of abundance.

Additional Analyses for PFMC

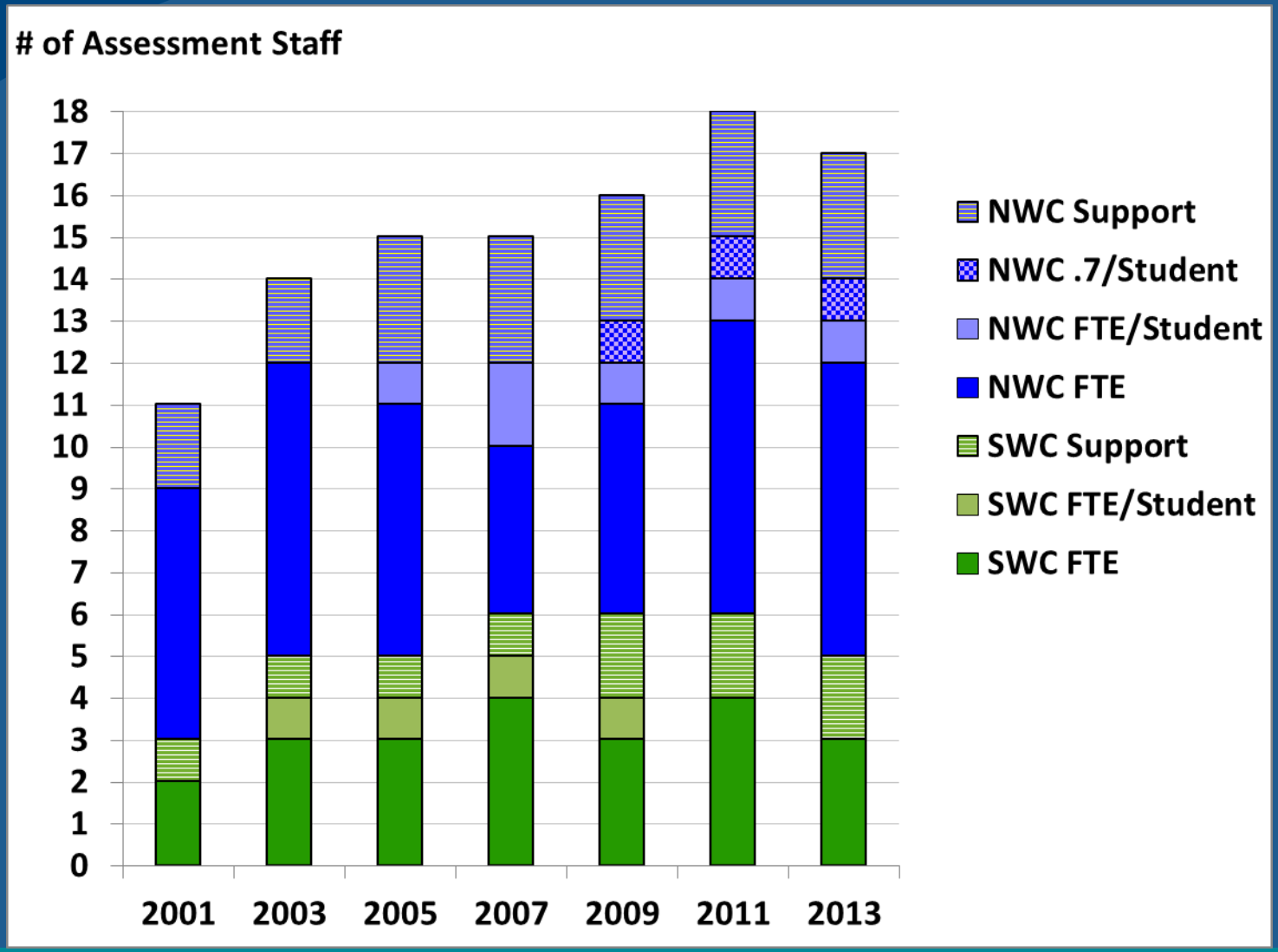
- Groundfish Management Team often requests projections under alternative ACL/ACT or SPR values.

- Council Staff request projections from time to time as well.
  - 2013/2014 analysis for EIS:10-year forward projections across multiple harvest specifications and states of nature (base and alternative model parameterizations) for all stocks with assessments (even if a decade old).

Current Staffing

- NWFSC
  - 9.7 Groundfish Stock Assessment Scientists
    - Tenure: a few days to ~15 years
      - Only one >7.5 years
  - 3 support staff
- SWFSC
  - 3 Groundfish Stock Assessment Scientists
  - 2 support staff

History of Staffing Levels



Staffing and Stock Assessments

(Example: 2013)

- 11.7 Stock Assessment Scientists (Including 2 Team Leads) + 5 support staff
  - 8 Benchmark stock assessments in SS (Including Pacific hake)
    - 7 different lead authors
    - 1-2+ additional authors per assessment
  - 1 update assessment (in SS)
  - 9 Data-Moderate assessments (some with multiple areas)
    - 2 sets of 2 authors for the 8 reviewed in Data-Moderate STAR panel
    - 1 reviewed in STAR panel outside of Data-Moderate panel
  - 3 Catch Reports for rebuilding stocks
  - A few data-poor assessments performed late in the process
  - 1 rebuilding analysis
  - >> 400 10-year projections of 37 assessments for PFMC EIS analysis

Evolution of Documentation

See B.2. for more information

- Simpler assessments documented methods and results along with needs for improvement in analysis.
- More complex assessments dependent on more diverse data led to increased need for documentation and review
- Terms of Reference with explicit document requirements
  - Executive summary with data used, assumptions/simplifications, main results and decision table.
  - Main document
  - Lists of tables and figures for display and diagnostics
  - Complete input files

Evolution of Review Process

See D. for more information

- GMT review – prior to 1998
  - 3-4 Research Fishery Biologists and others
  - *More dependence upon subsequent SSC review*
- Stock Assessment Review (STAR) panels – 1998
  - Developed to provide thorough and independent peer review
  - Response to industry concerns about science
  - Full week panels with analyses being done each day/night
    - Issue with review process morphing into a workshop
      - Effort to refocus on being a review process while recognizing need to explore alternatives such that the results are best available science.

Summary

- Stock assessment methods have evolved
- Complexity of benchmark assessments has increased in general
  - More common to have multiple authors than a decade ago
- Reductions in complexity of some assessments:
  - Use of data-moderate assessment methods
  - Simplifications in benchmark assessments when appropriate
- Assessment Category based upon:
  - assessment method
  - uncertainty in data and model outputs.
- NMFS staffing has increased a bit over time,
  - But so have quality of assessments, review and documentation,
  - Assessment contributions from state agencies/students have declined.

Strengths

- Advanced stock assessment software, which allows for
  - Wide variety of data types
  - Multitude of modeling approaches
- Generalized R code for inputs and outputs
- Variety of assessment methods provides management advice for:
  - stocks with different amounts and types of data,
  - insufficient resources to conduct and review full assessment.
- Data from variety of surveys and fishery data collection programs
- Dedicated and innovative stock assessment scientists
- Comprehensive review process by highly qualified reviewers

Challenges

- Data challenges:
  - Lack of coast-wide comprehensive survey in untrawlable habitat.
  - Inability to get accurate ages for a number of species
  - Surveys and fisheries generally stop at international boundaries
    - Fish do not
  - Delay in observing the size of a new recruitment
- Large number of species and small number of assessment scientists.
- Lack of stock assessment scientists from state agencies contributing
- Many demands on stock assessors time
- Many research projects to be conducted to improve stock assessment

Solutions

- Data:
  - Develop visual, hook and line, pot or other surveys for untrawlable habitat
  - Continue to explore and improve ageing methods
  - Work to collaborate across borders
  - Continued improvement in data management, analysis and assessment.
  - Continue to explore environmental indices that correlate with recruitment
  - Look at other methods to estimate recruitment strength.
- Increase number of stock assessment scientists across both centers
- Collaborate within NMFS and NOAA, with academics and NGOs
- Encourage states to become more engaged in stock assessment.